Prior to an Economic Treatment of Emissions and Their Uncertainties under the Kyoto Protocol:

Scientific Uncertainties that Must be Kept in Mind

M. Jonas and S. Nilsson (IIASA)

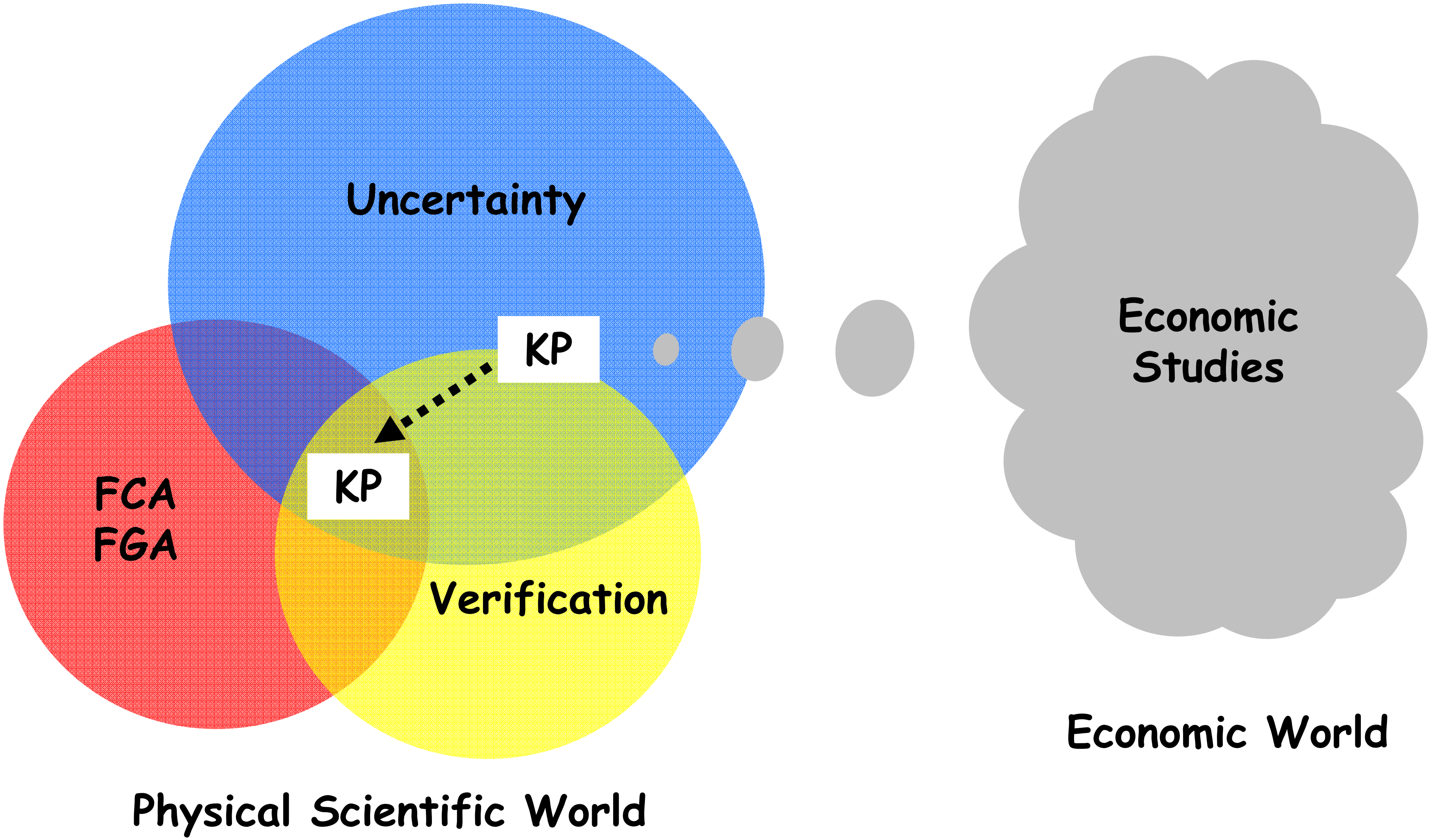
International Workshop on:

Uncertainty in Greenhouse Gas Inventories:
Verification, Compliance and Trading

Warsaw, Poland
24–25 September 2004

Contents:

Where this presentation will take you:



Economic studies placed into a physical scientific framework — so what?

Motivation:

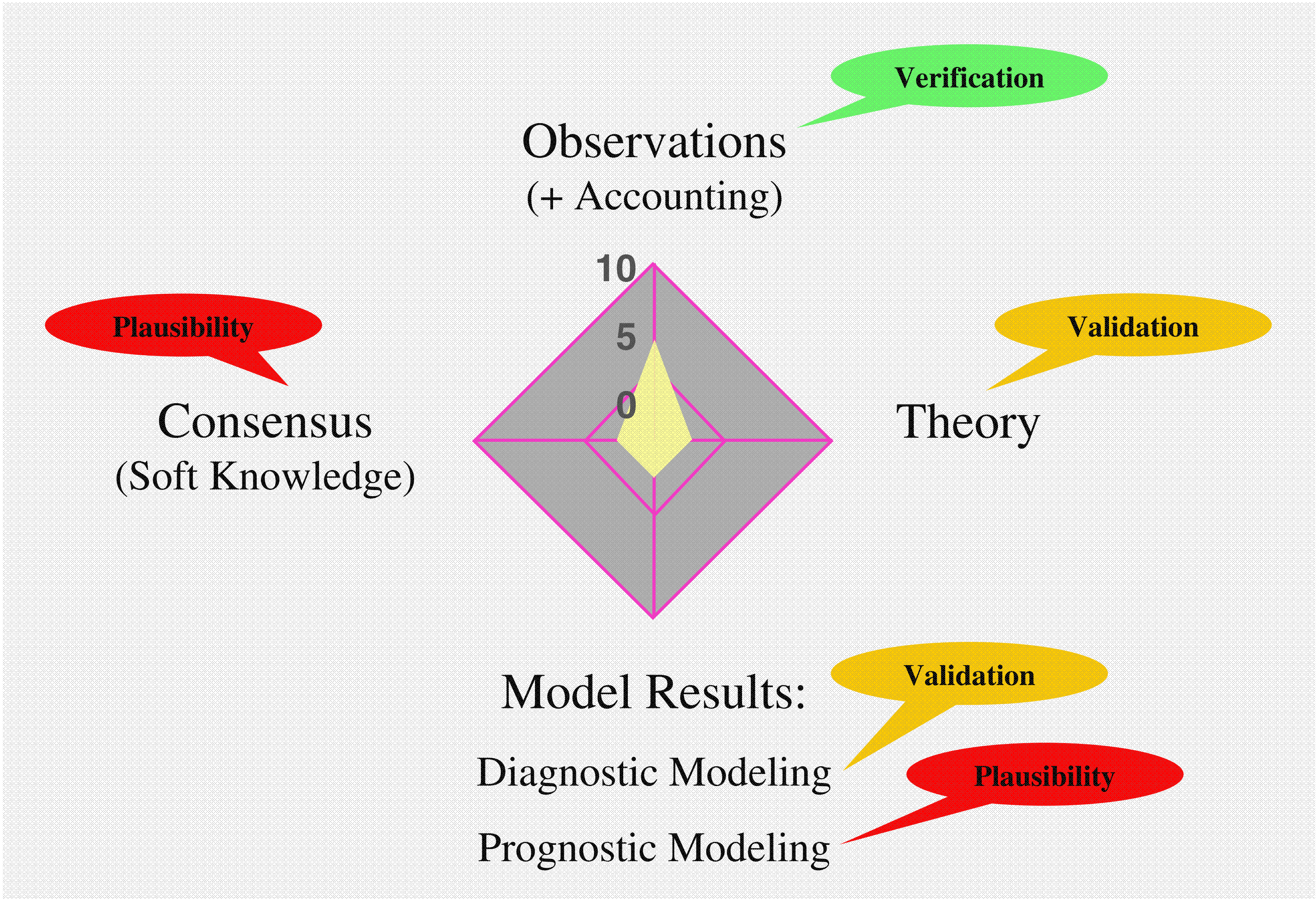
Two questions matter:

1. How credible are the emissions that I am paying for?
2. How will the emission price develop in the future?

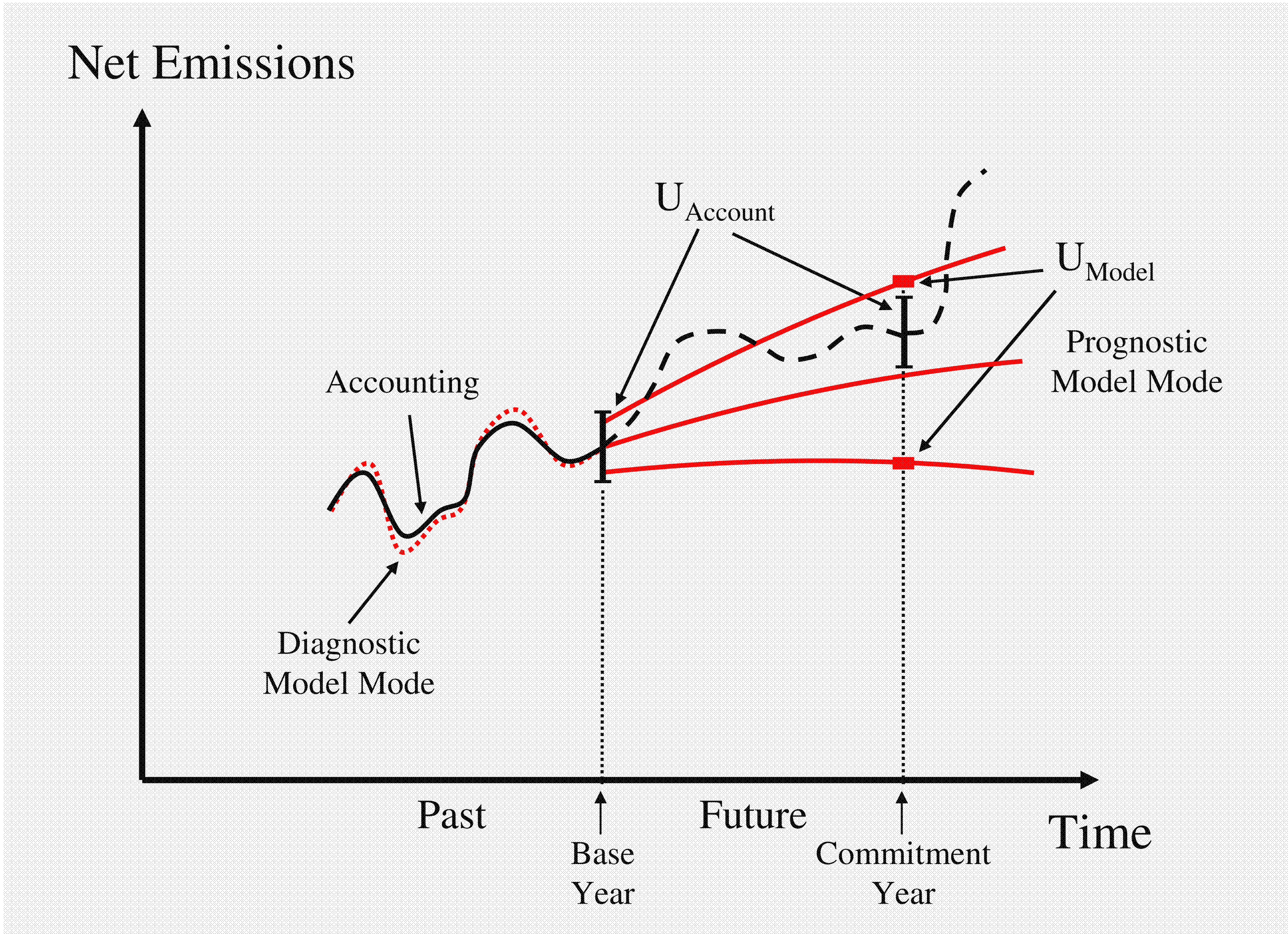
→ At the end of our presentation, you will know the answer to Question 1!

Contents:

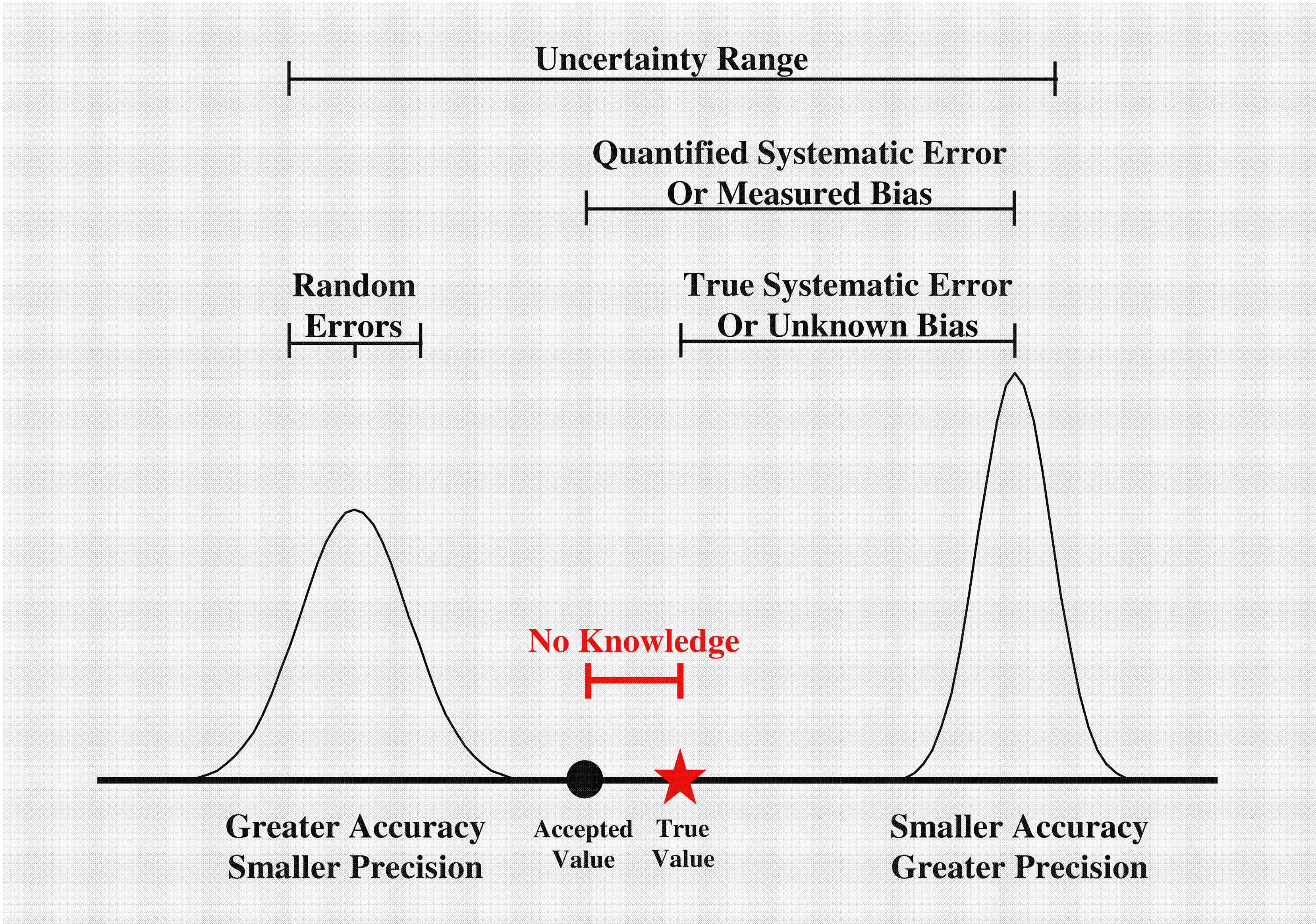
Scientific quality attached to Moss & Schneider's uncertainty concept:



Accounting vs Diagnostic and Prognostic Modeling:



The Applied Uncertainty Concept:



Our ACDb Experience: Uncertainty Classes

Class	Relative Uncertainty [%]	Qualitative Understanding Items in Focus: Fluxes and Pool Changes (Source/Sink Strengths)
1	0–5	Class 1 items have good potential to be considered in the Kyoto policy process. The greater the relative uncertainty, the wiser it is to treat fluxes/pool changes separately under the KP.
2	5–10	
3	10–20	
4	20–40	Major knowledge gaps exist. Class 4 items should be treated separately from class 1 items and not be intermingled. (Exception: When Class 4 items are negligible.)
5	> 40	

Contents:

1. Motivation

2. Working within a FGA–Uncertainty–Verification Framework

Step 0: Setting the Stage

Step 1: Bottom-up vs Top-down: Verification of Emissions

Step 2: Bottom-up/Top-down vs SD: Verification of Emission Changes

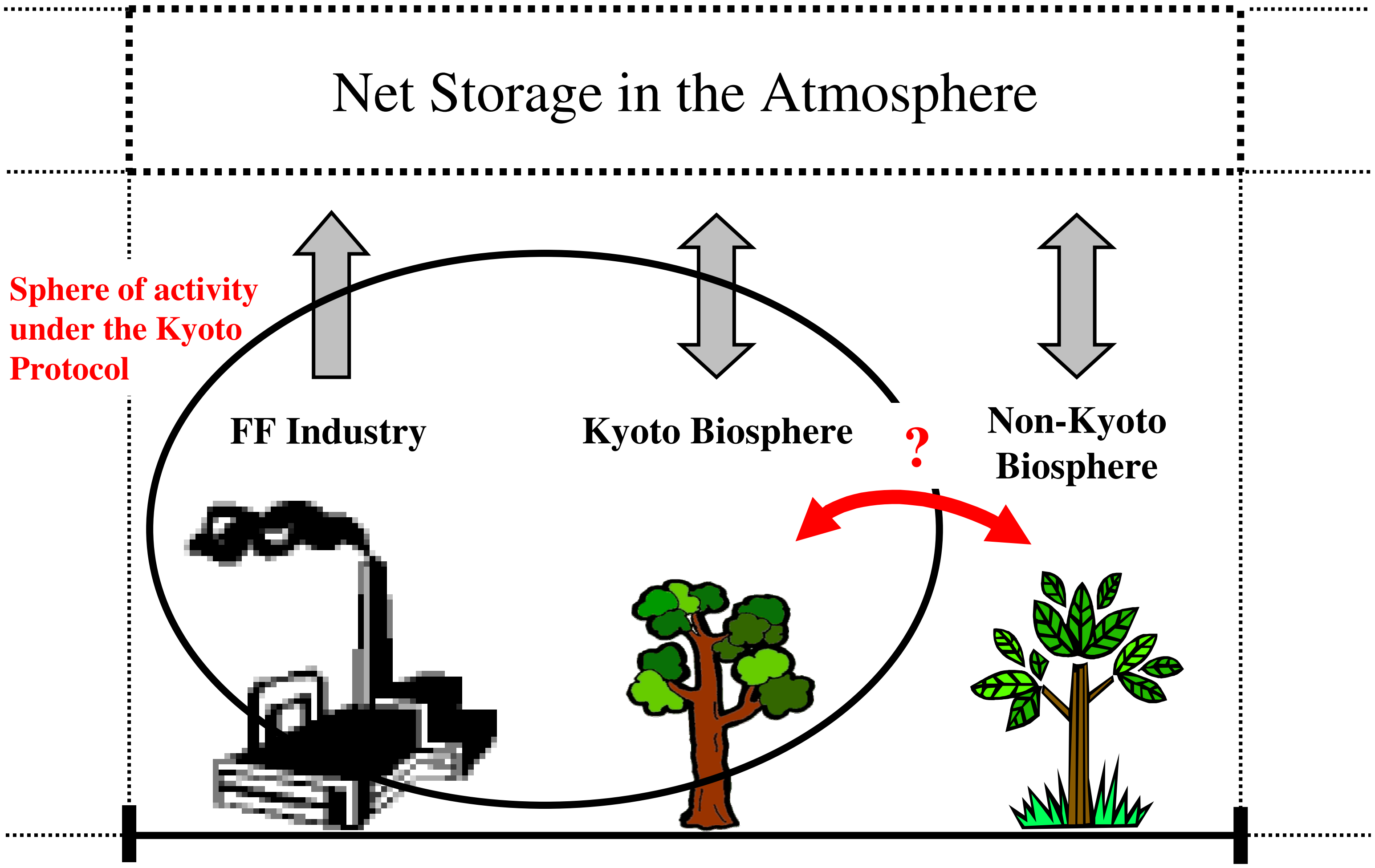
Step 3: Effectiveness vis-à-vis Compliance:
Statistical Significance vs Detectability

Step 4: Effectiveness vis-à-vis Credibility:
Uncertainty in the Accounting Matters

Step 5: SD: Different Techniques — Different Findings

3. Summary and Conclusion

PGA under the KP:



Country X

Can the Kyoto Protocol be verified?

Verification requires (following science theory!) bottom-up/top-down FGA

1. Atmospheric view
2. Completeness

... resolving countries!

The "basket approach" under the KP also includes gases that have both anthropogenic and natural sources (sinks). However, these are most crucial because ...

Lesson 1:

... the KP cannot be verified if the biosphere is split up into a "Kyoto biosphere" and a "non-Kyoto biosphere"! This is because an atmospheric measurement that can meet this discrimination requirement is not available.

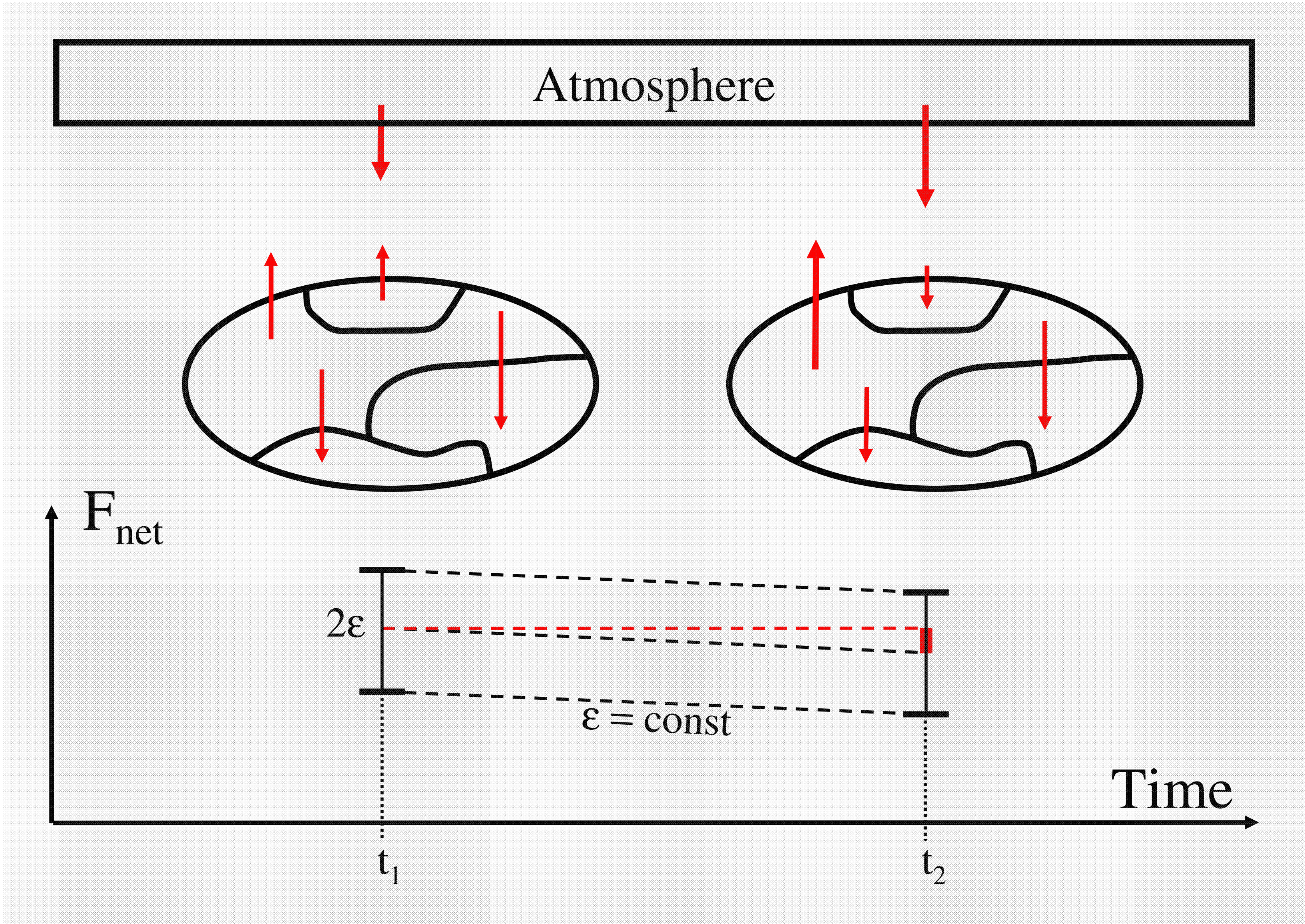
Contents:

But the KP focuses on emission changes:

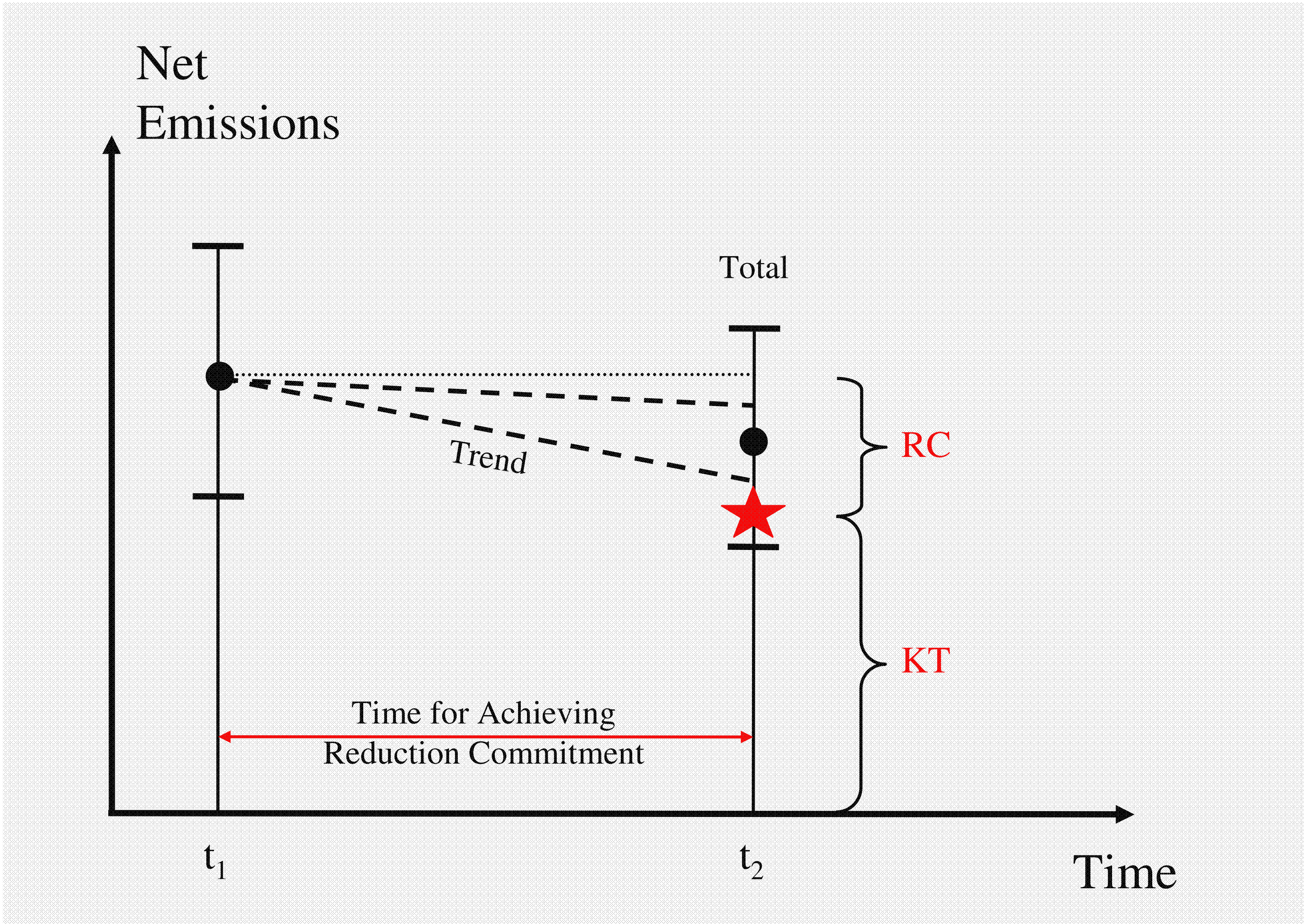
The KP requires that net emission changes (emission signals) of specified GHG sources and sinks, including those of the "Kyoto biosphere" but excluding those of the "non-Kyoto biosphere", be "verified" on the spatial scale of countries by the time of commitment, relative to a specified base year.

The relevant question then is whether these emission signals outstrip uncertainty and can be "verified" (correctly: detected).

But the KP focuses on emission changes:

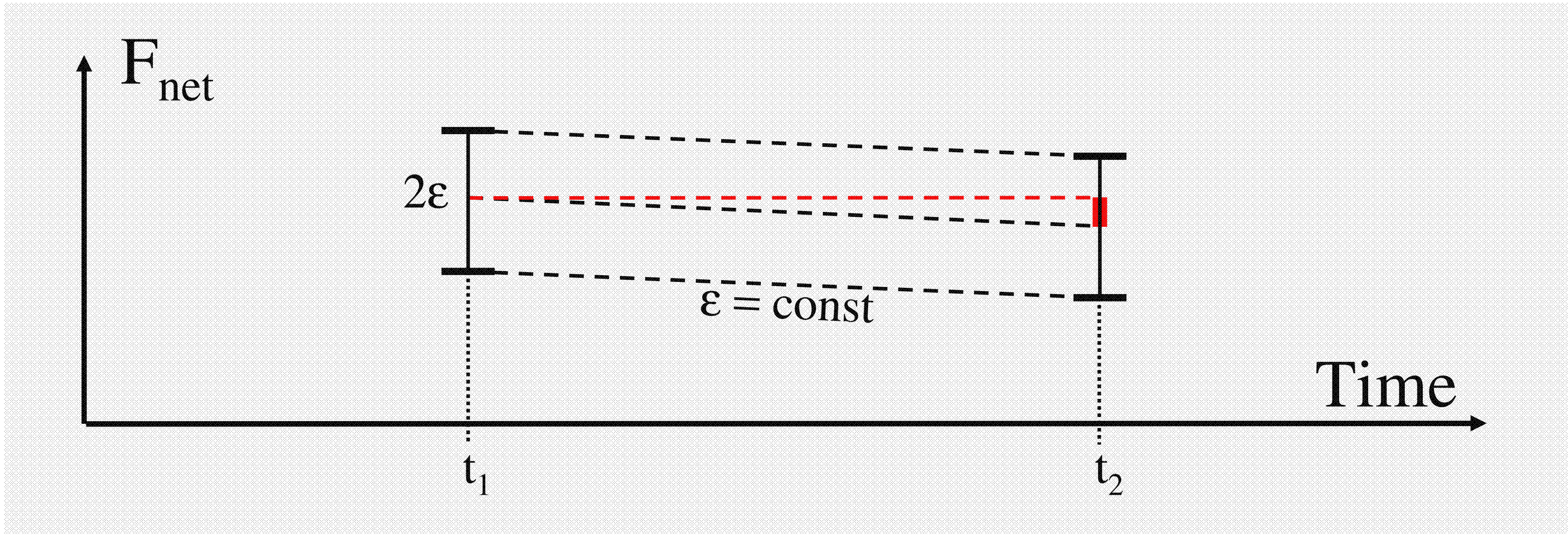


Total and Trend Unc Concepts of the IPCC:



It is the total uncertainty …

… in the commitment year/period that matters if we ever want to place SD meaningfully in a bottom-up/top-down verification context.

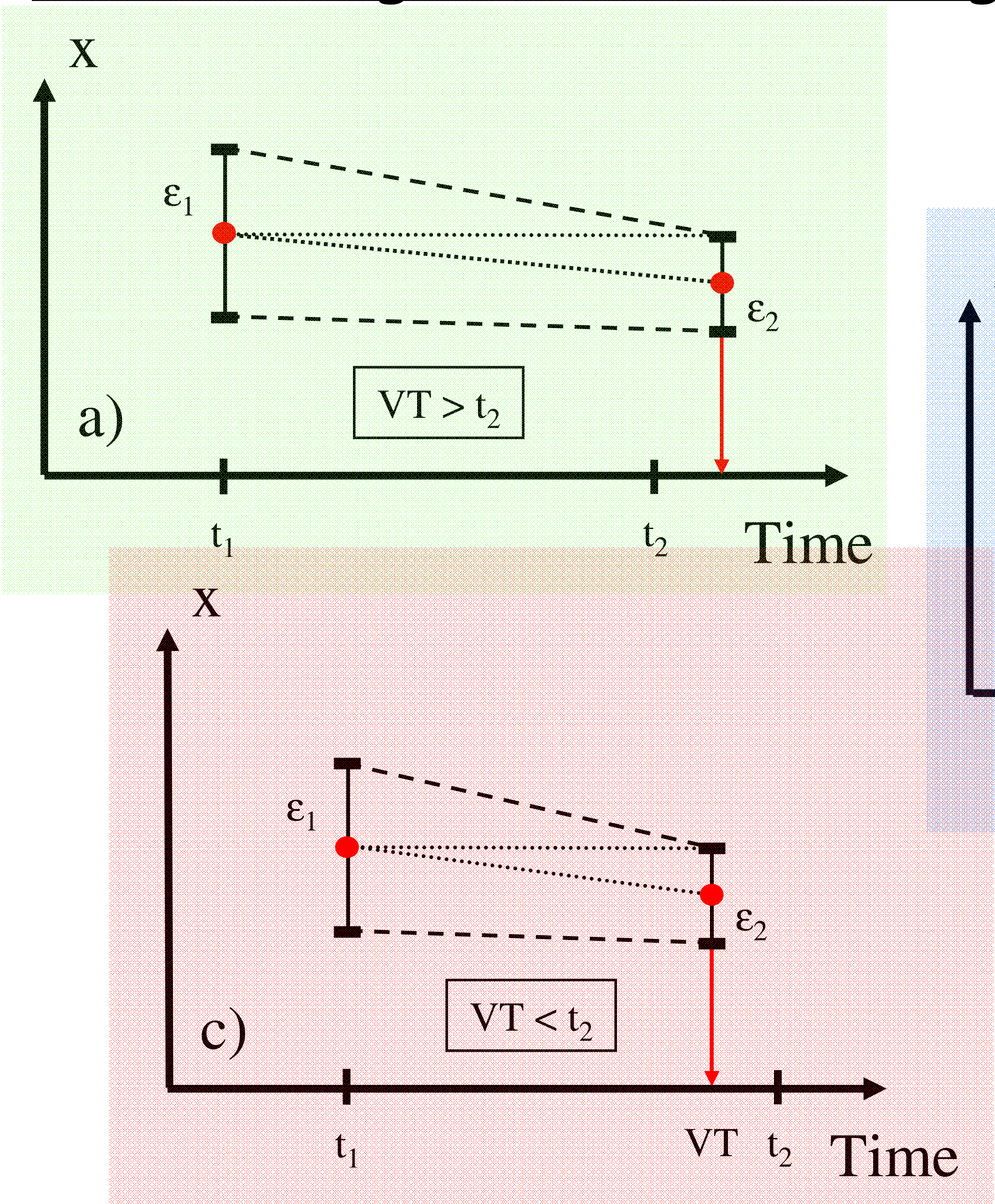


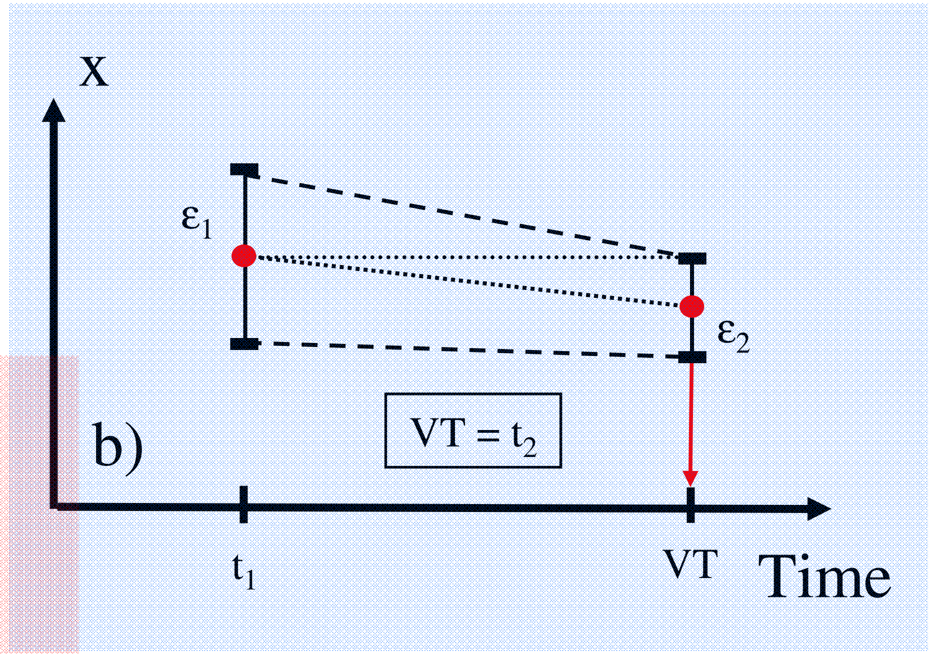
Lesson 2:

The temporal detection of emission changes cannot be placed meaningfully in a bottom-up/top-down verification context if SD does not acknowledge total uncertainty.

Contents:

Emission Signal: Statistical Significance vs Detectabilty

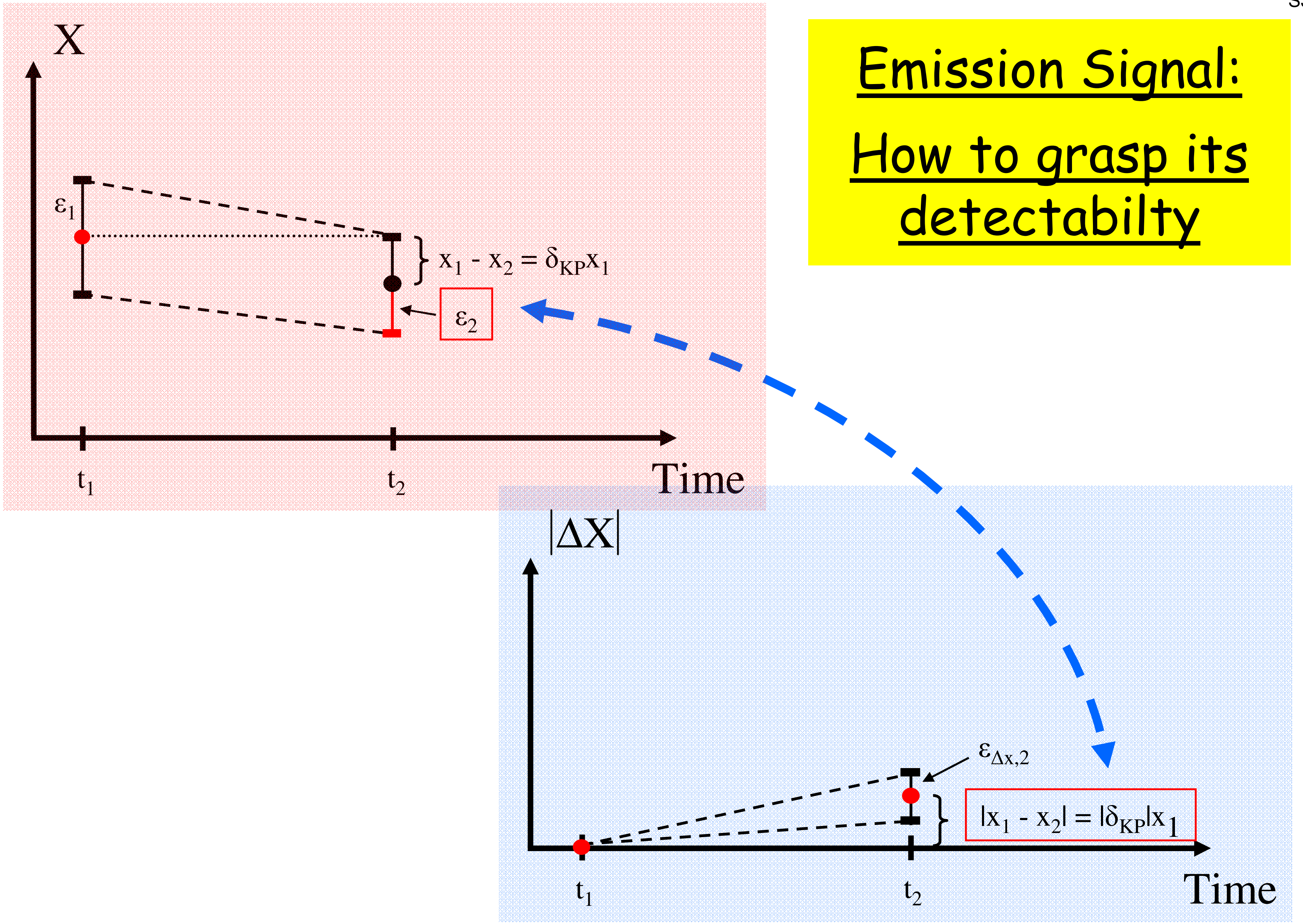




Statistical significance does not imply detectability!

Emission Signal:

How to grasp its detectabilty



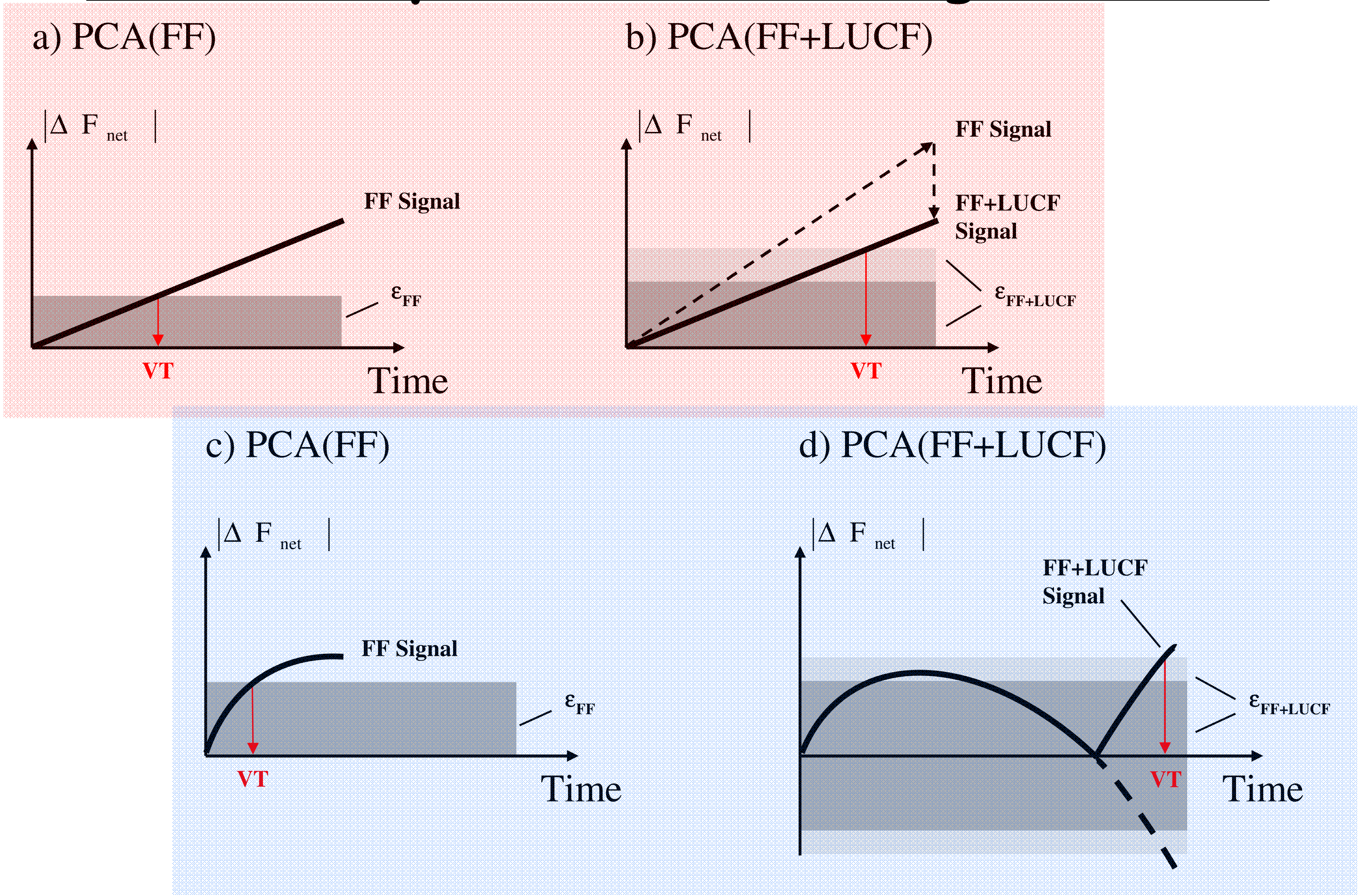
Emission Signal:
Statistical Significance vs Detectabilty

Lesson 3:

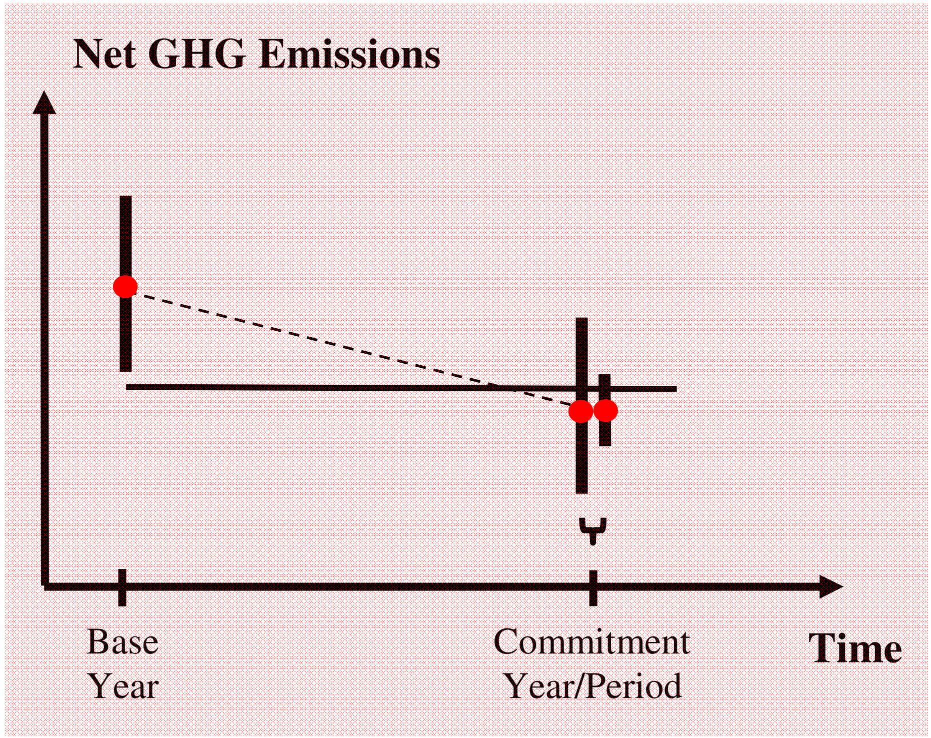
The knowledge of total uncertainty at only two points in time without considering the dynamics of the emission signal permits investigating its statistical significance but not its detectability.

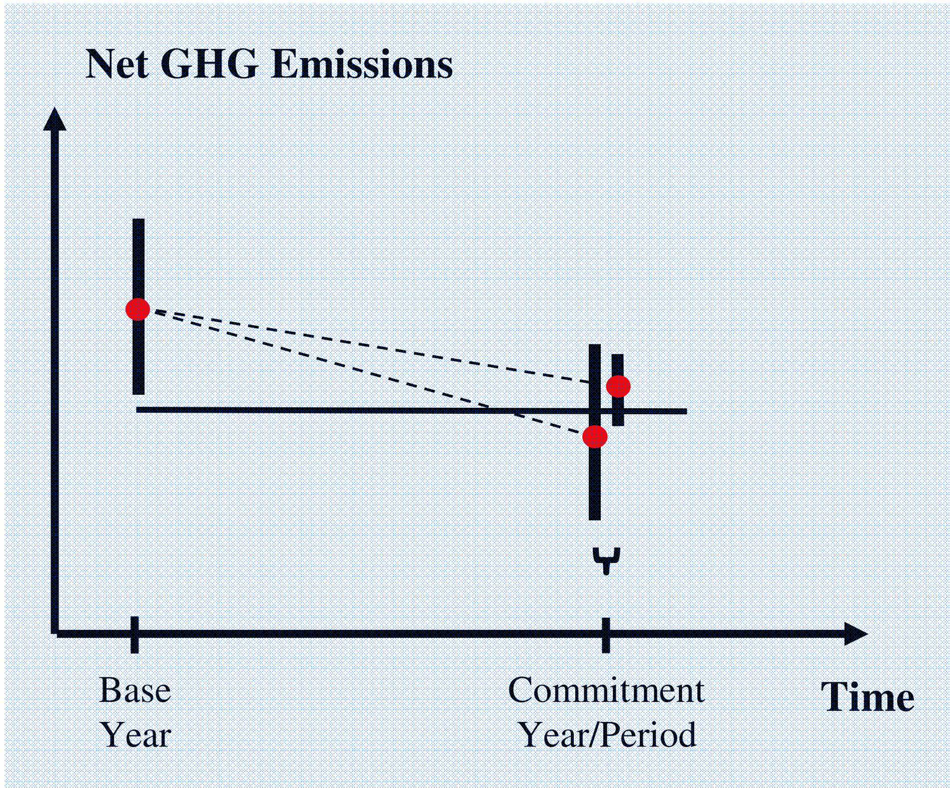
Contents:

Uncertainty in the accounting matters:



Uncertainty in the accounting matters:





Uncertainty in the accounting matters:

Lesson 4:

Without uncertainty, an effective (credible) emission trading system cannot be established.

Contents:

Signal Detection — Basics:

We distinguish between

- Preparatory SD

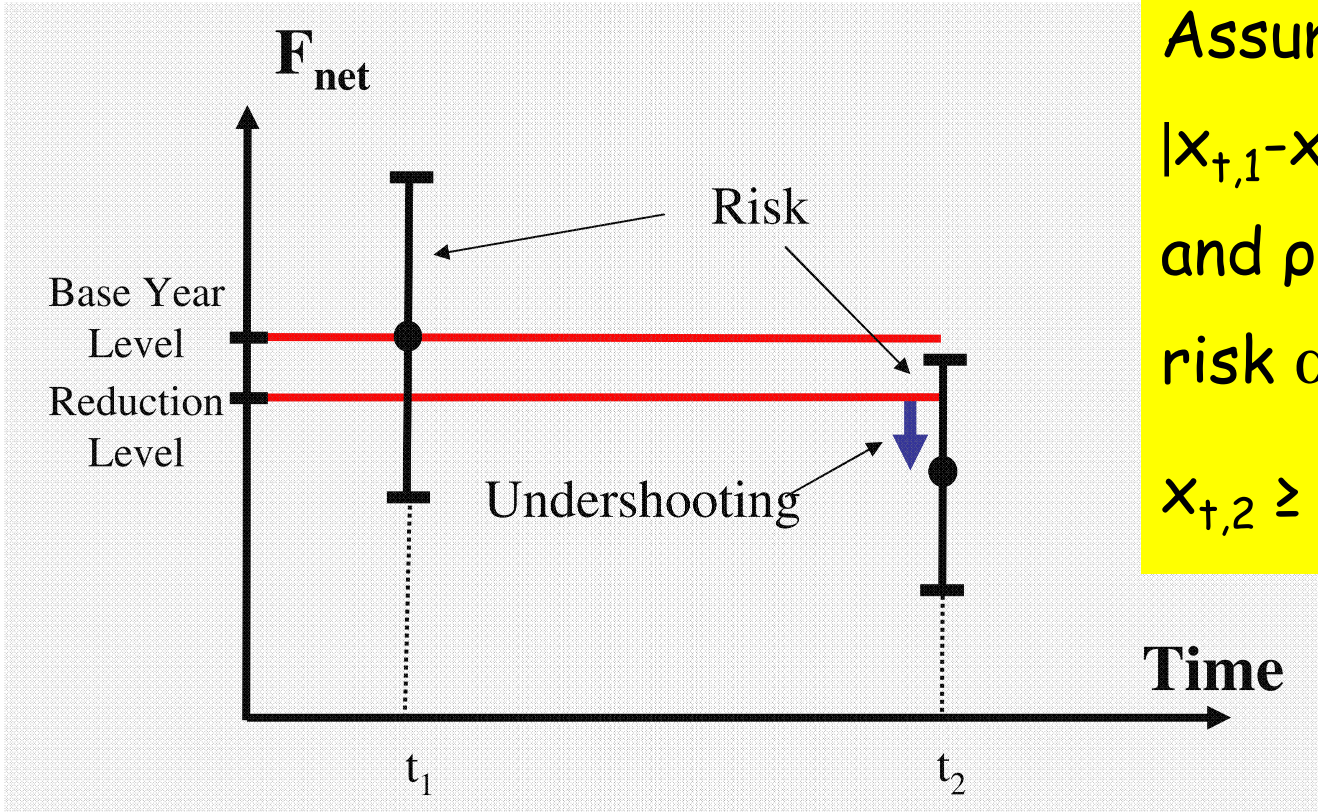
… addresses the question:

How well do we need to know net emissions if we want to detect a specified emission signal after a given time?

- Midway SD
- SD in Retrospect

No "what-if" type of prognostics involved!
Preparatory SD is also an excellent monitoring tool!

SD – Und Concept:



Assuming that

$|x_{t,1}-x_1| \leq \varepsilon_1$, $|x_{t,2}-x_2| \leq \varepsilon_2$

and $\rho_1 = \rho_2$, we find with

risk α:

$x_{t,2} \geq (1-\delta_{KP})\, x_{t,1} \quad \Leftrightarrow$

Und

$$\frac{x_2}{x_1} \leq (1-\delta_{KP})\frac{1-(1-2\alpha)\rho}{1+(1-2\alpha)\rho} \approx 1-\{\delta_{KP} + 2(1-2\alpha)(1-\delta_{KP})\rho\}$$

δ_{mod}

Und Concept:

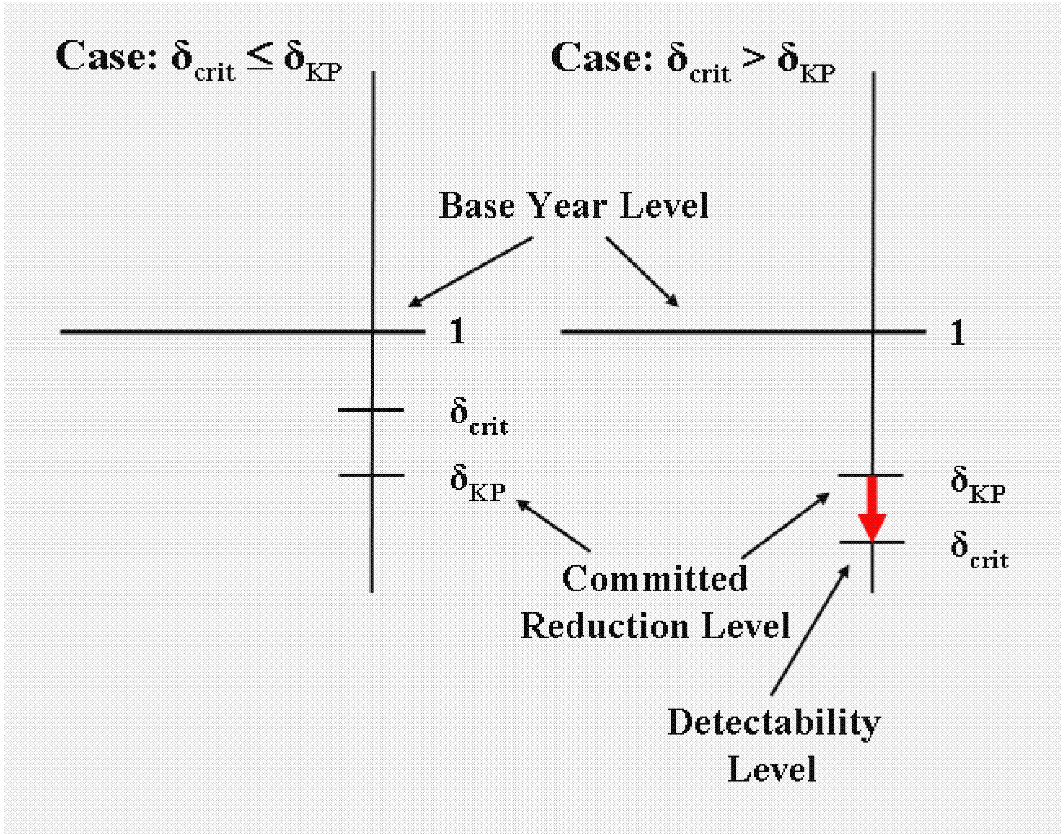
Accurate Results/ Emission Reduction

The Und Concept runs counter to the spirit of the KP!

Country Group	Max. Allow. VT t_2 - t_1 yr	KP Commit. δ_{KP} %	Modified Emission Limitation or Reduction Targets δ_{mod} in % for ρ = 2.5 %	7.5 %	15 %	30 %
			and			
			α = 0.0 α = 0.1 α = 0.3 α = 0.5	α = 0.0 α = 0.1 α = 0.3 α = 0.5	α = 0.0 α = 0.1 α = 0.3 α = 0.5	α = 0.0 α = 0.1 α = 0.3 α = 0.5
1a	20	8.0	12.5 11.6 9.8 8.0	20.8 18.4 13.4 8.0	32.0 27.7 18.4 8.0	50.5 43.6 27.7 8.0
1b	22					
1c	21					
1d	24					
2	20	7.0	11.5 10.6 8.8 7.0	20.0 17.5 12.4 7.0	31.3 26.9 17.5 7.0	49.9 43.0 26.9 7.0
3a	20	6.0	10.6 9.7 7.9 6.0	19.1 16.6 11.5 6.0	30.5 26.1 16.6 6.0	49.4 42.4 26.1 6.0
3b	24					
3c	22					
4	20	5.0	9.6 8.7 6.9 5.0	18.3 15.8 10.5 5.0	29.8 25.4 15.8 5.0	48.8 41.8 25.4 5.0

Annex I countries committed to emission limitation:
NZ, RU, UA; NO; AU; IS.

SD – Und&VT Concept:



Assuming that

$|x_{t,1}-x_1| \leq \varepsilon_1$, $|x_{t,2}-x_2| \leq \varepsilon_2$,

$\rho_1 = \rho_2$ and demanding detectability, we find with risk α:

$x_{t,2} \geq (1-\delta_{crit})\, x_{t,1} \quad \Leftrightarrow$

Und

$$\frac{x_1}{x_2} \leq (1-\delta_{crit})\frac{1}{1+(1-2\alpha)\rho} \approx 1-\left\{\delta_{KP} + U_{Gap} + (1-2\alpha)(1-\delta_{crit})\rho\right\}$$

δ_{mod}

Und&VT Concept:

Accurate Results/ Emission Reduction

Country Group	Max. Allow. VT t_2 t_1 yr	KP Com. δ_{KP} %	Crit. Targ. δ_{crit} % for ρ = 2.5% 7.5% 15% 30%	Modified Emission Limitation or Reduction Target δ_{mod} in % for ρ = 2.5 % and a = 0.0 a = 0.1 a = 0.3 a = 0.5	7.5 % a = 0.0 a = 0.1 a = 0.3 a = 0.5	15 % a = 0.0 a = 0.1 a = 0.3 a = 0.5	30 % a = 0.0 a = 0.1 a = 0.3 a = 0.5
1a 1b 1c 1d	20 22 21 24	8.0	2.4 7.0 13.0 23.1	10.2 9.8 8.9 8.0	14.4 13.2 10.7 8.0	24.4 22.4 18.0 **13.0**	40.8 38.0 31.3 **23.1**
2	20	7.0	2.4 7.0 13.0 23.1	9.3 8.8 7.9 7.0	13.5 12.3 9.7 7.0	24.4 22.4 18.0 **13.0**	40.8 38.0 31.3 **23.1**
3a 3b 3c	20 24 22	6.0	2.4 7.0 13.0 23.1	8.3 7.8 6.9 6.0	13.5 12.2 9.7 **7.0**	24.4 22.4 18.0 **13.0**	40.8 38.0 31.3 **23.1**
4	20	5.0	2.4 7.0 13.0 23.1	7.3 6.9 5.9 5.0	13.5 12.2 9.7 **7.0**	24.4 22.4 18.0 **13.0**	40.8 38.0 31.3 **23.1**

The Und&VT Concept runs counter to the Kyoto policy process!

Annex I countries committed to emission limitation:
NZ, RU, UA; NO; AU; IS.

SD: Different Techniques — Different Findings:

Lesson 5:

Signal detection techniques differ; each has its pros and cons. A discussion on which technique to select has not even started! Economists must be aware that the risk of compliance, i.e., that the countries' true emissions in the commitment year/period are above their true "Kyoto targets" can be grasped (although the countries' true net emissions are unknown) and thus be priced. We believe that not evaluating the countries' emission signals in terms of risk and detectability will miss economic reality.

Summary

We have 1) step-by-step specified the relevant conditions for carrying out temporal signal detection under the Kyoto Protocol and identified a number of scientific uncertainties that economic experts must keep in mind; and 2) answered the crucial question of how credible are tradable emission permits.

Conclusion

Our specific intention was to provide a basis for economic experts to carry out useful emission trading assessments and to specify the validity of their assessments from a physical scientific point of view.

Our general intention, however, was that we see a clear need for an intense interaction (both ways) between physical scientists and economic experts if we ever want the KP to become successful. We must begin to talk to each other!